In The Specification:

Please amend paragraphs [0003], [0008], [0009], [0011], [0019], [0020], [0022], [0024], [0032], [0033], [0036], [0037], and [0038] as follows:

[0003] When drilling boreholes for hydrocarbon extraction, it is common practice to circulate drilling fluid or "mud" downhole: drilling mud is pumped from the surface down a tubular drillstring to the drill bit, where the mud leaves the drillstring through jetting ports and returns to the surface via the annulus between the drillstring and the bore wall. The mud lubricates and cools the drill bit, supports the walls of the unlined bore, and carries dislodged rock particles or drill cuttings away from the drill bit and to the surface.

[0008] High mud pressure also has a number of undesirable effects on drilling efficiency. In deviated bores the drillstring may lie in contact with the bore wall, and if the bore intersects a lower pressure formation the fluid pressure acting on the remainder of the string will tend to push the string against the bore wall, significantly increasing drag on the string; this may result in what is known as "differential ~~sticking".~~ sticking."

[0009] It has also been suggested that high mud pressure at the bit reduces drilling efficiency, and this problem has been addressed in ~~US~~ United States Patents Nos. 4,049,066 ~~(Richey)~~ (*Richey*) and 4,744,426 ~~(Reed)~~ (*Reed*), the disclosures of which are incorporated herein by reference. Both documents disclose the provision of pump or fan arrangements in the annulus rearwardly of the bit, driven by mud passing through the drillstring, which reduces mud pressure at the bit. It is suggested that the disclosed arrangements improve jetting and the uplift of cuttings.

[0011] It is also known to aerate drilling mud, for example by addition of nitrogen gas, however the apparatus ~~by~~ necessary to implement this procedure is relatively expensive, cuttings suspension is poor, and the circulation of two phase fluids is

problematic. The presence of low density gas in the mud may also make it difficult to "kill" a well in the event of an uncontrolled influx of hydrocarbon fluids into the wellbore.

[0019] The differential between the drilling fluid pressure and the formation fluid pressure, which is likely to have been determined by earlier surveys, may be selected such that the drilling fluid pressure is high enough to prevent the formation fluid from flowing into the bore, but is not so high as to fracture or otherwise damage the formation. In certain embodiments, the pressure differential may be varied during a drilling operation to accommodate different conditions, for example the initial pressure differential may be controlled to assist in formation of a suitable filter cake. Alternatively, the drilling fluid pressure may be selected to be lower than the formation fluid pressure, that is the invention may be utilised to carry out "underbalance" drilling; in this case the returning drilling fluid may carry formation fluid, which may be separated from the drilling fluid at the surface.

[0020] Preferably, energy is added to the drilling fluid by at least one pump or fan arrangement. Most preferably, the pump is driven by the fluid flowing down through the drillstring, such as in the arrangements disclosed in ~~US~~ United States Patents Nos. 4,049,066 and 4,744,426. Fluid driven downhole pumps are also produced by Weir Pumps Limited of Cathcart, Glasgow, United Kingdom. The preferred pump form utilises a turbine drive, that is the fluid is directed through nozzles onto turbine blades which are rotated to drive a suitable impeller acting on the fluid in the annulus. Such a turbine drive is available, under the TurboMac trade mark, from Rotech of Aberdeen, United Kingdom. When using the preferred pump form the initial pump pressure at the surface will be relatively high, as energy is taken from the fluid, as it flows down through the string, to drive the pump. Alternatively, in other embodiments it may be possible for the pump to be driven by a downhole motor, to be electrically powered, or indeed driven by any suitable means, such as from the rotation of the drillstring.

[0022] In one embodiment of the invention, a ~~proportion~~ portion of the circulating drilling fluid may be permitted to flow directly from the drillstring bore to the annulus

above the formation, and such diversion of flow may be particularly useful in boreholes of varying diameter, the changes in diameter typically being step increases in bore diameter. When the bore diameter increases, drilling fluid flow speed in the annulus will normally decrease, and the additional volume of fluid flowing directly from the drillstring bore into the annulus assists in maintaining flow speed and cuttings entrainment. This may be achieved by provision of one or more bypass subs in the string. The bypass subs may be selectively operable to provide fluid bypass only when considered necessary or desirable.

[0024] The drillstring may also be provided with means for agitating cuttings in the annulus, such as the flails disclosed in ~~US~~ United States Patent No. 5,651,420 ~~(Tibbets et al)~~ (*Tibbets, et al.*), the disclosure of which is incorporated herein by reference. ~~Tibbets et al~~ *Tibbets, et al.* propose mounting flails on elements of the drillstring, which flails are actuated by the rotation of the string or the flow of drilling fluid around the flails. Most preferably however, the agitating means are mounted on a body which is rotatable relative to the string. The body is preferably driven to rotate by drive means actuated by the flow of drilling fluid through the string, but may be driven by other means. This feature may be provided in combination with or separately of the main aspect of the invention.

[0032] Reference is first made to Figure 1 of the drawings, which illustrates a conventional drilling operation. A rotating drill string 12 extends through a borehole 14, and drilling mud is pumped from the surface down the drill string 12, to exit the string via jetting ports (not shown) in a drill bit 16, and returns to the surface via the annulus 17 between the string 14 and the bore hole wall.

[0033] Reference is now also made to Figure 2 of the drawings, which is a sketch graph of the pressure of the drilling mud at various points in the wellbore 14 as illustrated in Figure 1. The mud enters the drillstring at the surface at a relatively high pressure P_1, and emerges from the bit 16 at a lower pressure P_2 reflecting the pressure losses resulting from the passage of the mud through the string 12 and bit 16. The

drilling mud returns to the surface via the annulus 17 and reaches surface at close to atmospheric pressure P_3.

[0036] Figure 5 is a sketch graph of the pressure of circulating drilling mud in a drilling operation utilizing a single pump assembly 36 as described in Figure 4, the pump 36 being located in the string such that the pump 36 remains above the hydrocarbon-bearing formation during the drilling operation. The solid line is the same as that of the graph of Figure 2, and illustrates the circulating mud pressure profile in a comparable conventional wellbore drilling operation. The dashed line illustrates the effect on the circulating mud pressure resulting from the provision of a pump assembly 36 in the drillstring 32, as will be described. At the surface, the mud pressure must be higher than conventional; shown by point 52, and then drops gradually due to pressure losses to point 54, where the fluid in the drill string 32 passes through the pump turbine motor section 46 and transfers energy to the fluid in the annulus 50, as reflected by the rapid loss of pressure, to point 56. As the mud emerges from the drillstring 32 at the drill bit 16, it is apparent that the pressure or ECD of the mud, at point 58, is lower than would be the case in a conventional drilling operation, despite the higher initial mud pressure 52. As the return mud passes up through the annulus 50 it loses pressure gradually until reaching the pump 36, at point 60, whereupon it receives an energy input in the form of a pressure boost 62, to ensure that the mud will flow to the surface with the cuttings entrained in the mud flow. As with a conventional drilling operation, the mud exits the string 32 at close to atmospheric pressure, at point 64.

[0037] The pressure of the fluid in the formation 33 will have been determined previously by surveys, and the location of the pump 36 and the mud pressure between the points 58, 60 ~~is~~ are selected such that there is a predetermined pressure differential between the drilling fluid pressure and the formation fluid pressure. In most circumstances, the drilling fluid pressure will be selected to be higher than the formation fluid pressure, to prevent or minimise the flow of formation fluid into the bore, but not so high to cause formation damage, that is at least below the fracture gradient.

[0038] Thus, it may be seen that the present invention provides a means whereby the ECD in the section of wellbore intersecting the hydrocarbon-bearing formation may be effectively reduced or controlled to provide a predetermined pressure differential between the drilling fluid and the formation fluid without the need to reduce the mud pressure elsewhere in the wellbore or impact on cuttings entrainment. This ability to reduce and control the ECD of the drilling mud in communication with the hydrocarbon-bearing formation allows drilling of deeper and longer wells while reducing or obviating the occurrence of formation damage, and will reduce or obviate the need for formation pore plugging materials, thus reducing drilling costs and improving formation production.